



Europäisches  
Patentamt

European  
Patent Office

Office européen  
des brevets

01.04.2004

**BEST AVAILABLE COPY**

REC'D 22 JUN 2004

WIPO

PCT

Bescheinigung

Certificate

Attestation

Die angehefteten Unterla-  
gen stimmen mit der  
ursprünglich eingereichten  
Fassung der auf dem näch-  
sten Blatt bezeichneten  
europäischen Patentanmel-  
dung überein.

The attached documents  
are exact copies of the  
European patent application  
described on the following  
page, as originally filed.

Les documents fixés à  
cette attestation sont  
conformes à la version  
initialement déposée de  
la demande de brevet  
européen spécifiée à la  
page suivante.

Patentanmeldung Nr. Patent application No. Demande de brevet n°

03425203.1

**PRIORITY  
DOCUMENT**  
SUBMITTED OR TRANSMITTED IN  
COMPLIANCE WITH RULE 17.1 (a) OR (b)

Der Präsident des Europäischen Patentamts;  
Im Auftrag

For the President of the European Patent Office

Le Président de l'Office européen des brevets  
p.o.

R C van Dijk



Anmeldung Nr:  
Application no.: 03425203.1  
Demande no:

Anmeldetag:  
Date of filing: 02.04.03  
Date de dépôt:

Anmelder/Applicant(s)/Demandeur(s):

DAYCO EUROPE S.r.l.  
Zona Industriale Vallecupa  
64010 Colonnella (Teramo)  
ITALIE  
Bayerische Motoren Werke Aktiengesellschaft  
Petuelring 130  
80809 München  
ALLEMAGNE

Bezeichnung der Erfindung/Title of the invention/Titre de l'invention:  
(Falls die Bezeichnung der Erfindung nicht angegeben ist, siehe Beschreibung.  
If no title is shown please refer to the description.  
Si aucun titre n'est indiqué se référer à la description.)

Two-arm belt tensioner

In Anspruch genommene Priorität(en) / Priority(ies) claimed / Priorité(s)  
revendiquée(s)  
Staat/Tag/Aktenzeichen/State/Date/File no./Pays/Date/Numéro de dépôt:

Internationale Patentklassifikation/International Patent Classification/  
Classification internationale des brevets:

F16H7/08

Am Anmeldetag benannte Vertragsstaaten/Contracting states designated at date of  
filing/Etats contractants désignées lors du dépôt:

AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IT LU MC NL  
PT RO SE SI SK TR LI

5

## TWO-ARM BELT TENSIONER

The present invention relates to a two-arm belt  
10 tensioner for an internal combustion engine belt drive.

As is known, in engine belt drives, an endless  
belt connects the drive shaft to an electric machine  
and possibly one or more auxiliary members. When using  
a reversible electric machine, i.e. capable of  
15 operating both as a motor and generator, in which case,  
the belt branches have different tensions, depending on  
the operating mode of the electric machine, belt  
tension is controlled using two-arm belt tensioners.

The most commonly used two-arm belt tensioners  
20 comprise two belt tensioning arms, which have  
respective hinge portions mounted to rotate on the same  
hinge pin about a common axis, and support respective  
idle pulleys, each acting on a respective branch of the  
belt. The two arms are loaded towards each other by a  
25 normally spiral forcing spring located between the  
hinge portions of the arms to force the idle pulleys  
against the respective belt branches and so compensate  
for variations in belt tension.

Though widely used, known belt tensioners of the type described above have the drawback of being extremely bulky, particularly in directions perpendicular to the hinge axis, and therefore  
5 unsuitable for highly compact combustion engines. This is mainly due to the type of forcing spring used, the size of which is determined by the spring having to provide sufficient force to ensure correct tensioning of the belt, while at the same time being flexible  
10 enough to cater to continual variations in the tension of the belt branches.

It is an object of the present invention to provide a two-arm belt tensioner designed to provide a straightforward, low-cost solution to the above  
15 problem, and in particular a two-arm belt tensioner which is highly compact, reliable and efficient, and is cheap and easy to produce.

According to the present invention, there is provided a two-arm belt tensioner for a belt drive of  
20 an internal combustion engine; the belt tensioner comprising a tubular supporting portion fixed to a fixed supporting structure; a first and a second arm fitted to said tubular supporting portion to rotate about a common hinge axis; a first and a second idle  
25 wheel fitted to respective ends of said first and said second arm and cooperating with respective branches of a belt of said drive; and elastic forcing means for forcing said first and said second arm towards each

other to keep said wheels in contact with said respective branches of the belt; characterized in that said elastic forcing means comprise a torsionally elastic elongated member extending through said tubular supporting portion, coaxially with the hinge axis, and having respective opposite end portions projecting outwards of said tubular supporting portion; a first and a second end cap located at opposite axial ends of said tubular supporting portion, and each fitted in angularly fixed manner to a respective said end portion; said second cap being fitted integrally with one end of said second arm, and defining a radial opening fitted through with said first arm; angular connecting means being interposed between said first arm and said first cap, and housed inside said tubular supporting portion and said first and said second cap.

A non-limiting embodiment of the invention will be described by way of example with reference to the accompanying drawings, in which:

Figure 1 shows a side view of an internal combustion engine belt drive featuring a two-arm belt tensioner in accordance with the teachings of the present invention;

Figures 2 and 3 show sections along lines II-II and III-III respectively in Figure 1;

Figure 4 shows a section, with parts removed for clarity, along line IV-IV in Figure 3;

Figure 5 shows a variation of a detail in Figure

4;

Figure 6 is similar to Figure 2, and shows, with parts removed for clarity, a variation of a detail in Figure 2.

5        Number 1 in Figure 1 indicates as a whole a belt drive for connecting the output shaft 2 of an internal combustion engine 3 to the shaft 4 of a reversible electric machine 6, i.e. capable of operating as a current generator or motor, and to a shaft 5 of an  
10    auxiliary member 7, e.g. an air-conditioning system compressor.

More specifically, drive 1 comprises a pulley 8 fitted to shaft 2 of the engine; a pulley 9 integral with shaft 4 of the electric machine; and a pulley 10  
15    integral with shaft 5 of auxiliary member 7. Pulleys 8, 9 and 10 are wound with an endless belt 11, which has a first branch 12 extending between pulleys 8 and 9, a second branch 13 extending between pulleys 9 and 10, and a third branch 14 extending between pulleys 8 and  
20    10. Belt 11 is conveniently a poly-V type, and pulleys 8, 9 and 10 each have a corresponding work profile (not shown) with multiple grooves.

With reference to Figure 1, drive 1 also comprises a two-arm belt tensioner 16 cooperating with belt 11 to  
25    ensure correct tensioning of branches 12 and 13 in any operating condition.

Belt tensioner 16 (Figures 1 to 3) comprises a fixed supporting structure 18, in turn comprising a

curved connecting bracket 19 surrounding the outer casing or frame of electric machine 6, to which it is connected by means of screws, as shown in Figure 1. Bracket 19 is fitted integrally with a cylindrical tubular body 20 extending coaxially with an axis 21 parallel to the axes of rotation 2a and 4a of shafts 2 and 4. Belt tensioner 16 also comprises a first and a second straight forcing arm 24 and 23, which are connected to supporting structure 18 to rotate in opposite directions about axis 21, and support respective idle wheels 25, 26 cooperating respectively with branches 12 and 13 of belt 11. Preferably, each arm 23, 24 comprises two contoured portions 27 of the same shape and size and made of pressed sheet metal. Portions 27 of the same arm face and contact each other on opposite sides of a central plane P of symmetry of relative wheel 25, 26, which plane is perpendicular to the axis A of rotation of the relative wheel. Portions 27 are connected integrally to each other, e.g. welded, riveted, or by other equivalent joining means, to define, on each arm 23, 24, a fork-shaped end portion 28, to which the relative idle wheel 25, 26 is hinged, and a root or connecting portion 29 separated from the fork-shaped end portion by a straight intermediate portion 29a. The fork-shaped end portion 28 of each arm 23, 24 has arms 28a, each of which has an integral variable-diameter cylindrical projection 28b, which, when portions 27 are connected to each other, extends

coaxially with axis A towards the other projection 28b to define, together with the other projection 28b, a hinge pin to which the relative wheel 25, 26 is mounted to rotate about relative axis A via the interposition  
5 of a relative rolling-contact bearing.

Root portion 29 of arm 24 is defined by two adjacent fastening collars 30, whereas root portion 29 of arm 23 is fork-shaped, and comprises two coaxial fastening collars 31 spaced apart sufficiently to  
10 loosely house collars 30 of arm 24 in between.

Root portions 29 of arms 23 and 24 are connected to tubular body 20 by an elastic connecting and forcing device 33 allowing both arms 23 and 24 to rotate about axis 21, and which, in use, pushes arms 23 and 24  
15 towards each other.

As shown particularly in Figures 2 and 3, elastic device 33 comprises a torsionally elastic elongated member 34, which has a constant, conveniently hexagonal, section, extends coaxially with axis 21, and  
20 is defined by a number of parallel, adjacent, elongated bodies 35 (Figures 4 and 5) having respective identical sections in a plane perpendicular to axis 21. Preferably, elongated bodies 35 are cylindrical with a circular section, or prismatic with a triangular,  
25 conveniently equilateral, section. In which latter case, bodies 35 are arranged so that each lateral surface contacts a lateral surface of an adjacent body 35, as shown in Figure 4.



Elastic member 34 comprises an intermediate portion 36 housed loosely inside tubular body 20; and two opposite end portions 37 and 38 projecting outwards of tubular body 20, and onto which are driven or force-fitted the outer end portions 39 of respective  
5 cylindrical end caps 40 and 41, which define an axial extension of tubular body 20.

More specifically, cap 40 has the same outside diameter as tubular body 20, and comprises a collar-shaped further end portion 42, opposite relative  
10 portion 39, which loosely houses elastic member 34, and in which is firmly connected an end portion of a torsionally rigid, cylindrical tubular sleeve 43 coaxial with axis 21, and whose opposite end portion  
15 43a engages cap 41 in rotary manner about axis 21, and rests against an inner axial shoulder of cap 41. Elastic member 34 extends loosely inside tubular sleeve 43, which loosely engages tubular body 20 and is connected to the tubular body by two bushes 44 of  
20 antifriction material, one of which has an outer radial flange interposed between portion 42 of cap 40 and tubular body 20.

Cap 41 has two end portions of the same outside diameter as cap 40; and an intermediate portion having  
25 two outer radial flanges 45 spaced axially apart and joined by a curved wall 45a. Flanges 45 define respective shoulders, on each of which a relative collar 31 of arm 23 rests and is locked in angularly

fixed manner. A circumferential slot 46 is formed through the lateral wall of cap 41, between flanges 45, and is fitted through loosely with intermediate portion 29a of arm 24, the collars 30 of which are housed  
5 inside cap 41, coaxially with axis 21, and are fitted to end portion 43a of sleeve 43 in axially and angularly fixed manner, conveniently by a force fit onto an externally splined portion of portion 43a. A cylindrical portion of bush 44 and a further  
10 antifriction bush 48 are interposed between cap 41 and the end portion of sleeve 43; and two rings, also of antifriction material, are interposed between cap 41 and collars 30, and located on opposite axial sides of collars 30 (Figure 2 and 3).

15 In the Figure 6 variation, sleeve 43 is replaced by a further hollow, torsionally elastic member, in this case a wire torsion spring 51, which is connected integrally at opposite ends to cap 40 and arm 24, e.g. with the interposition of a sleeve (not shown) for  
20 supporting arm 24 and connected in rotary and axially fixed manner to tubular body 20. The further elastic member, in this case spring 51, thus defines, with elongated member 34, an elastic assembly defined by two parallel torsionally elastic bodies located one inside  
25 the other.

By providing at least one elastic forcing member coaxial with the common hinge axis of arms 23 and 24, and two straightforward end caps 40 and 41 for

connecting the opposite ends of the elastic member angularly to arms 23 and 24, the resulting two-arm belt tensioner is therefore much more compact radially than conventional belt tensioners. Moreover, the particular  
5 dimensions of caps 40 and 41 provide for obtaining a belt tensioner, in which tubular body 20, cap 40 and at least part of cap 41 are housed entirely or lie within a straight cylindrical surface K parallel to axis 21, and an intermediate portion of which is defined by the  
10 outer lateral surface of fixed tubular supporting body 20 itself. Obviously, being of constant transverse size along the hinge axis, and in particular of the same size as the tubular supporting body, the range of applications of the two-arm belt tensioner is greatly  
15 increased to also include even particularly compact drives.

Using caps fitted directly to the opposite ends of the elastic member obviously also reduces production cost and, above all, assembly cost and time. Caps 40  
20 and 41, in fact, define respective axial locating and locking stops for both the torsionally elastic member or members 43, 51, and for arms 23 and 24. The caps/torsionally elastic elongated member combination also provides for obtaining a stable assembly in which  
25 the various parts, including the fixed tubular supporting body 20 are packed tightly together by means of a single straightforward axial forcing operation, so that arms 23 and 24 operate in axially fixed positions

with a constant desired amount of damping. The relative positions of all the various components involved, in fact, are ensured by being determined by respective axial shoulders.

5        Using caps 40 and 41 also provides for immediate, stable connection of arms 23 and 24 to the elastic forcing device. Both the arms, in fact, are simply driven axially onto respective cylindrical portions forming part of the caps directly, or of bodies  
10       connected integrally to the caps.

      Making the elastic member from a bundle of elastic bodies having the same cross section and/or different contacting outer surfaces in relative motion and/or different torsional rigidities, provides for obtaining  
15       an elastic forcing body which is highly elastic, while at the same time capable of exerting the necessary force on the belt to keep the branches taut.

      Striking the right balance between elasticity and applied force is also assisted by the further  
20       torsionally elastic member, e.g. spring 51, which is located compactly parallel to and coaxial with the main elastic member 34, and can be selected from a number of torsional members of different elastic characteristics. The symmetry of the arms provides for action exchange  
25       between the belt and the idle wheels, all lying in plane P; and the fact that the contoured portions of the arms are identical makes the arms modular, so that each can be made using a single die.

Finally, projections 28b integral with the arms of the fork-shaped end portions enables the wheels to be fitted to the arms with no need for screws, and simultaneously with assembly of the arms.

5        Clearly, changes may be made to belt tensioner 16 as described herein without, however, departing from the scope of the present invention. In particular, arms 23, 24, end caps 40, 41, member 34, and, if provided, further elastic member 51 may be formed otherwise than  
10 as described by way of example. In particular, the arms need not necessarily be curved or symmetrical; and different ways may be provided of connecting caps 40 and 41 to the torsionally elastic member or members, and the arms to the caps.

CLAIMS

1) A two-arm belt tensioner (16) for a belt drive (1) of an internal combustion engine (3); the belt tensioner (16) comprising a tubular supporting portion (20) fixed to a fixed supporting structure (6); a first (24) and a second (23) arm fitted to said tubular supporting portion (20) to rotate about a common hinge axis (21); a first (25) and a second (26) idle wheel fitted to respective ends (28) of said first (24) and said second (23) arm and cooperating with respective branches (12)(13) of a belt (11) of said drive; and elastic forcing means (33) for forcing said first (24) and said second (23) arm towards each other to keep said wheels (25)(26) in contact with said respective branches (12)(13) of the belt (11); characterized in that said elastic forcing means (33) comprise a torsionally elastic elongated member (34) extending through said tubular supporting portion (20), coaxially with the hinge axis (21), and having respective opposite end portions (37)(38) projecting outwards of said tubular supporting portion (20); a first (40) and a second (41) end cap located at opposite axial ends of said tubular supporting portion (20), and each fitted in angularly fixed manner to a respective said end portion (37)(38); said second cap (41) being fitted directly with one end (31) of said second arm (23), and defining a radial opening (46) fitted through with said

first arm (24); angular connecting means (43; 51) being interposed between said first arm (24) and said first cap (40), and housed inside said tubular supporting portion (20) and said first and said second cap  
5 (40) (41).

2) A belt tensioner as claimed in Claim 1, characterized by comprising axial locating and locking means (40, 41, 45) for keeping said elongated torsionally elastic member (34) and said first and said  
10 second arm (24) (23) in axially fixed positions with respect to said tubular supporting portion (20); said axial locating and locking means comprising said first (40) and said second (41) cap.

3) A belt tensioner as claimed in Claim 2,  
15 characterized in that said axial locating and locking means comprise two shoulders (45) carried by said second cap (41); said second arm (23) resting on said shoulders and being forced onto said second cap (41).

4) A belt tensioner as claimed in one of the  
20 foregoing Claims, characterized in that said first (40) and said second (41) cap are force fitted onto the respective end portions (37) (38) of said elongated torsionally elastic member (34).

5) A belt tensioner as claimed in any one of the  
25 foregoing Claims, characterized in that said tubular supporting portion (20), said first cap (40), and at least part of said second cap (41) are housed completely or lie within a straight cylindrical surface

(K) parallel to the hinge axis (21); an intermediate portion of said cylindrical surface (K) being defined by an outer lateral surface of said tubular supporting portion (20).

5        6) A belt tensioner as claimed in any one of the foregoing Claims, characterized in that said angular connecting means comprise a torsionally rigid tubular sleeve (43) connected integrally to said first cap (40) and having an end portion (43a) engaging said second  
10 cap (41) in rotary manner about said hinge axis (21); said first arm (24) being connected integrally to said end portion (43a) of the tubular sleeve.

      7) A belt tensioner as claimed in Claim 6, characterized in that said angular connecting means  
15 comprise a further torsionally elastic member (51).

      8) A belt tensioner as claimed in Claim 7, characterized in that said further torsionally elastic member (51) extends parallel to said elongated torsionally elastic member (34), and is connected to  
20 said first arm (24) and to said first cap (40) in parallel with said elongated torsionally elastic member (34).

      9) A belt tensioner as claimed in Claim 8, characterized in that said further torsionally elastic  
25 member comprises at least one wire torsion spring (51) surrounding said elongated torsionally elastic member (34).

      10) A belt tensioner as claimed in any one of the



foregoing Claims, characterized in that said elongated torsionally elastic member (34) comprises a number of elongated bodies (35) having the same cross section.

11) A belt tensioner as claimed in Claim 10,  
5 characterized in that said elongated bodies (35) have a substantially circular cross section.

12) A belt tensioner as claimed in Claim 10,  
characterized in that said elongated bodies (35) have a  
triangular cross section with substantially equal  
10 sides.

13) A belt tensioner as claimed in any one of the foregoing Claims, characterized in that said first (24) and said second (23) arm each comprise two contoured portions (27) of the same shape and size.

14) A belt tensioner as claimed in Claim 13,  
15 characterized in that said contoured portions (27) of each arm extend on opposite sides of a relative central plane (P) of symmetry of the relative wheel (25) (26), which plane is perpendicular to the axis of rotation of  
20 the relative said wheel.

15) A belt tensioner as claimed in Claim 13 or 14, characterized in that said contoured portions (27) are made of pressed sheet metal.

16) A belt tensioner as claimed in Claim 14 or 15,  
25 characterized in that said contoured portions contact, and are connected integrally to, each other.

17) A belt tensioner as claimed in one of Claims 13 to 16, characterized in that the contoured portions

of each arm define at least one end fork (28) having  
respective arms (28a); each arm of the end fork having  
a relative cylindrical projection (28b) forming part of  
a hinge pin coaxial with a relative axis (A) and to  
5 which the relative wheel (25, 26) is mounted to rotate  
about the relative axis (A).

ABSTRACT

In a belt drive (1) of an internal combustion engine (3), a two-arm belt tensioner (16) has a fixed  
5 tubular supporting portion (20); a first (24) and a  
second (23) arm fitted to the tubular supporting  
portion (20) to rotate about a common hinge axis (21),  
and supporting respective idle wheels (25) (26)  
cooperating with respective branches (12) (13) of the  
10 drive belt (11); and an elastic device (33) for forcing  
the arms (23) (24) towards each other; the elastic  
device (33) having a torsionally elastic elongated  
member (34) extending through the tubular supporting  
portion (20), coaxially with the hinge axis (21), and  
15 having respective opposite end portions (37) (38)  
projecting outwards of the tubular supporting portion  
(20); the end portions (37) (38) being fitted with  
respective end caps (40) (41), one of which is fitted  
directly with one of the arms (23) (24), and houses one  
20 end, connected integrally to the other cap, of the  
other arm.

(Figure 1)

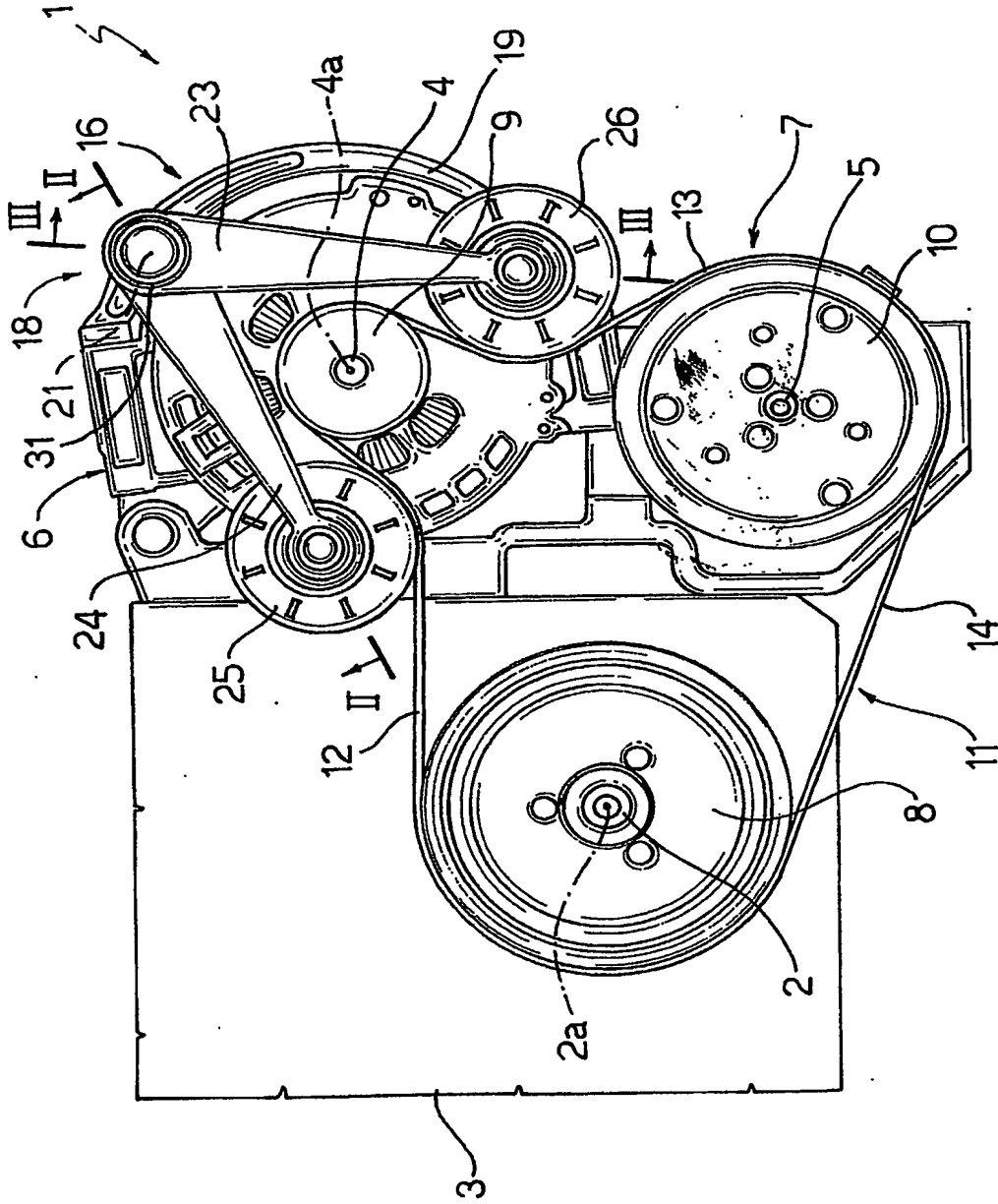
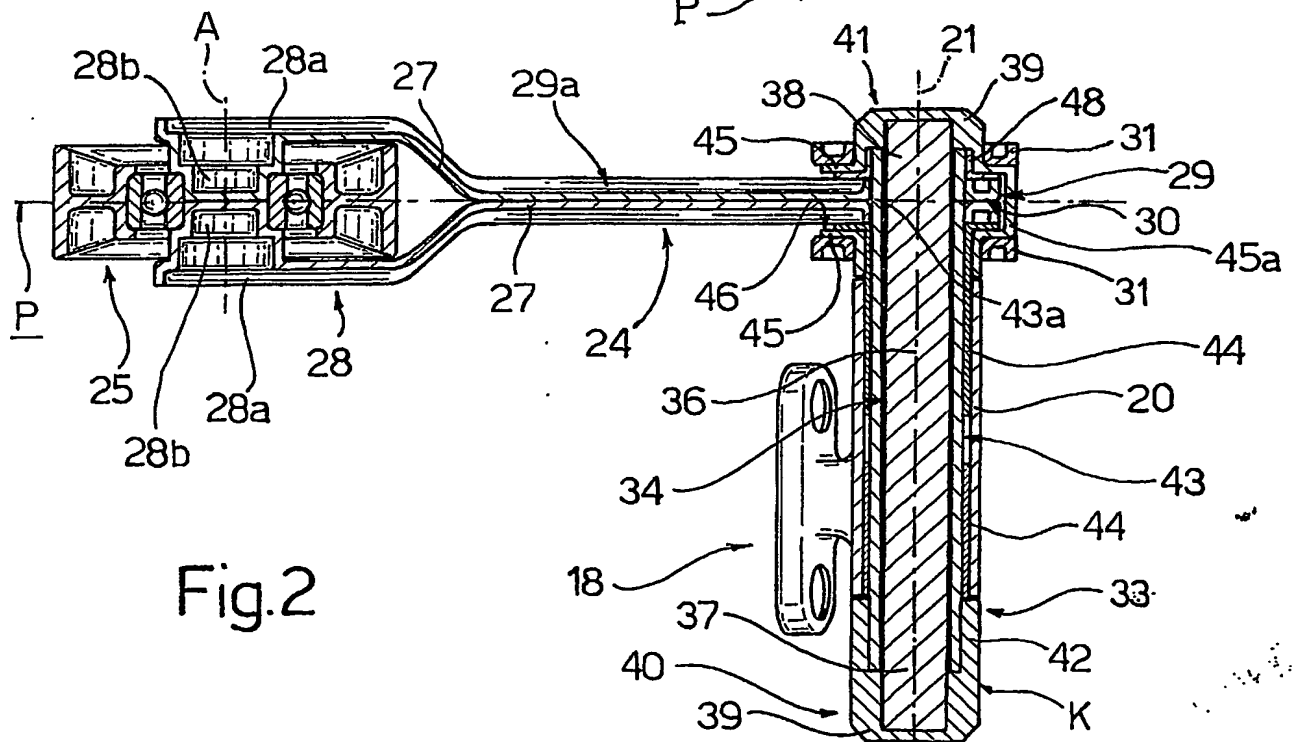
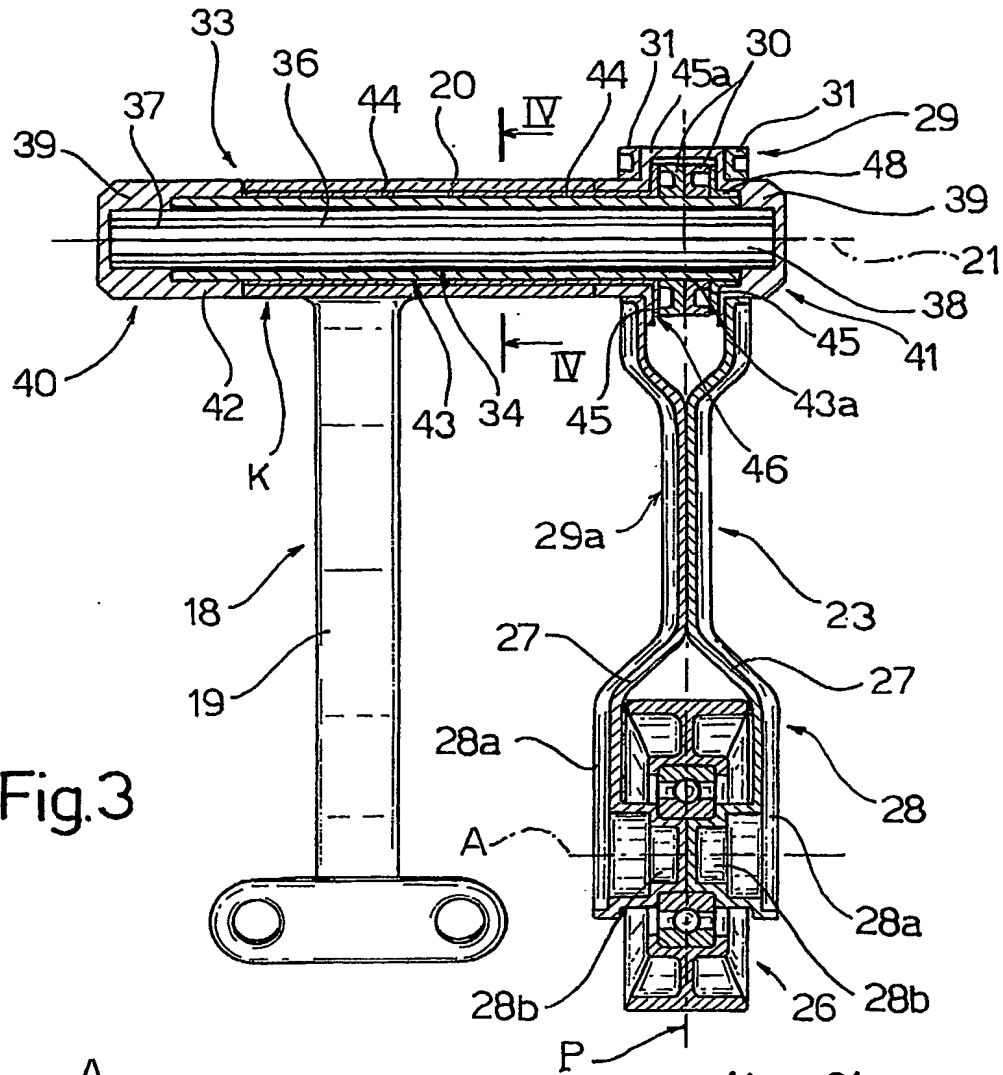


Fig.1



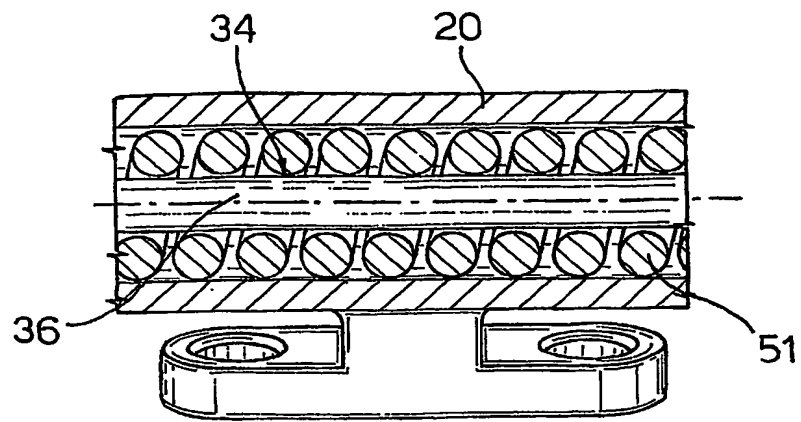


Fig.6

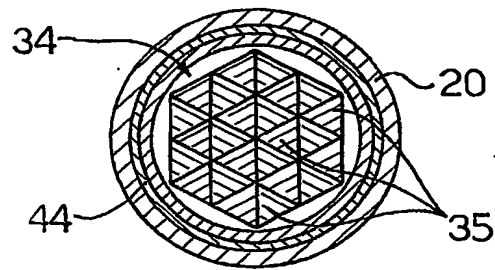


Fig.4

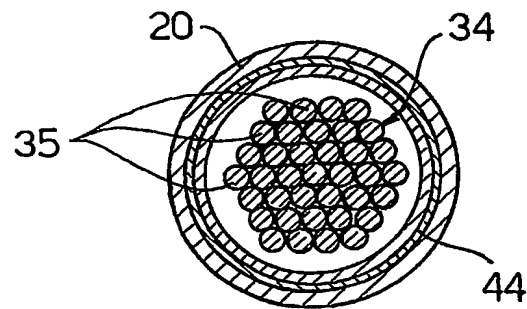


Fig.5

**This Page is Inserted by IFW Indexing and Scanning  
Operations and is not part of the Official Record**

**BEST AVAILABLE IMAGES**

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images include but are not limited to the items checked:

- ☐ **BLACK BORDERS**
- ☐ **IMAGE CUT OFF AT TOP, BOTTOM OR SIDES**
- ☐ **FADED TEXT OR DRAWING**
- ☐ **BLURRED OR ILLEGIBLE TEXT OR DRAWING**
- ☐ **SKEWED/SLANTED IMAGES**
- ☐ **COLOR OR BLACK AND WHITE PHOTOGRAPHS**
- ☐ **GRAY SCALE DOCUMENTS**
- ☒ **LINES OR MARKS ON ORIGINAL DOCUMENT**
- ☐ **REFERENCE(S) OR EXHIBIT(S) SUBMITTED ARE POOR QUALITY**
- ☐ **OTHER:** \_\_\_\_\_

**IMAGES ARE BEST AVAILABLE COPY.**

**As rescanning these documents will not correct the image problems checked, please do not report these problems to the IFW Image Problem Mailbox.**